
PIGNOLET INSTRUMENTS

**CATALOGUE NUMBER FOURTEEN
PORTABLE AND SWITCHBOARD TYPES**

of

**AMMETERS
VOLTMETERS**

and

VOLT-AMMETERS

and

DIRECTIONS FOR TESTING

PIGNOLET
CONTINUOUS CURRENT
VOLTMETERS, AMMETERS AND
: : : VOLT-AMMETERS : : :

THESE instruments are of the permanent magnet type, and have the high accuracy and equal scale divisions of that type.

EACH instrument is specially calibrated, and most thoroughly inspected. The magnets are of imported special steel, and are carefully treated to insure permanency. The instruments are constructed in the same thorough manner as the larger types of this class. Each has jewel bearings, carefully ground, hardened steel pivots, and embody improvements fully protected by patents.

ALL the instruments are guaranteed, and any defects will be repaired without charge if the instrument is returned, with seals intact, within six months from date of purchase.

Pack carefully instruments returned for repairs and attach name and address of owner. Ship by express prepaid.

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: : PORTABLE INSTRUMENTS : :



THE portable instruments are twice the size of the illustration, and are large enough for all practical purposes, although of a convenient pocket size.



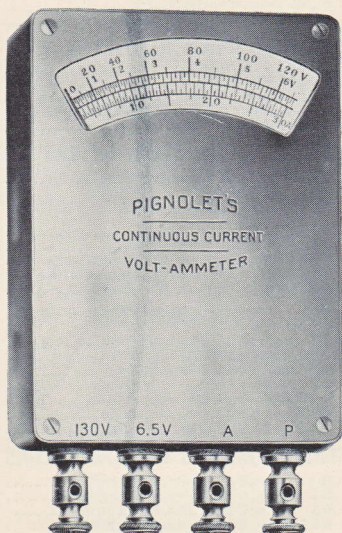
THE volt-ammeters have a wide range of usefulness, for each instrument is equally effective as a voltmeter or as an ammeter. The special volt-ammeters with adjustments for resistance measurements have the following resistances: 100 Ohms for the 5 volt range; 500 Ohms for 25 volt range; 1,000 Ohms for 50 volt range; 2,000 Ohms for 100 volt range. In addition each division of the voltmeter scale equals one milliamper. These adjustments permit resistances to be easily determined by the rule given later. Instruments Nos. 213 and 253 have resistances of 150 and 3,000 Ohms, but will be furnished on special order with resistances of 100 and 2,000 Ohms so that they can be used for measuring resistances by the above mentioned rule. While this method of using these instruments has not the range or accuracy of a Wheatstone Bridge, yet it enables the resistance of ordinary coils, circuits, etc., to be determined with sufficient accuracy for all practical purposes.



THE Dead Beat attachment is operated by turning a knob, provided on the cover of the instrument, which sets the pointer a little below the reading to be measured, so that the pointer has but a short distance to move when the current is turned on. These pointers come to rest quickly, so that ordinarily this attachment is not needed. It is, however, advantageous where many similar measurements are to be made, as in testing a number of storage batteries or dry cells.

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: : PORTABLE INSTRUMENTS : :



ONE-HALF ACTUAL SIZE

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: : PORTABLE INSTRUMENTS : :

Catalogue Number	VOLTMETERS Range	List Price Each
200	0-5, Tenth volt divisions.....	\$9.00
201	0-10, Fifth volt divisions.....	9.00
202	0-20, Half volt divisions.....	9.00
203	0-50, Single volt divisions.....	10.00
204	0-100, Two volt divisions....	10.00
205	0-130, Two volt divisions.....	11.00
206	0-260, Five volt divisions.....	13.00

DOUBLE READING VOLTMETERS

*210	0-5 and 0-25 volts.....	12.00
*211	0-5 and 0-50 volts.....	12.00
*212	0-5 and 0-100 volts.....	12.00
213	0-6.5 volts in tenths, and 0-130 volts.....	13.00
214	0-130 and 0-260 volts.....	14.00

VOLTMETERS FOR STORAGE BATTERIES

215	0-3, Twentieth volt divisions.....	9.00
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AMMETERS

220	0-1, .02 ampere divisions.....	9.00
221	0-4, Tenth ampere divisions.....	9.00
222	0-10, Fourth ampere divisions.....	9.00
223	0-15, Half ampere divisions.....	9.00
224	0-30, Single ampere divisions.....	9.00

VOLT-AMMETERS

230	0-5 volts and 0-30 amperes.....	11.00
231	0-10 volts and 0-30 amperes.....	11.00
232	0-20 volts and 0-30 amperes.....	11.00
233	0-50 volts and 0-30 amperes.....	12.00
234	0-100 volts and 0-30 amperes.....	12.00
235	0-130 volts and 0-30 amperes.....	13.00
236	0-260 volts and 0-30 amperes	15.00

THREE-READING VOLT-AMMETERS

*250	0-5 volts, 0-25 volts, 0-30 amperes.....	16.00
*251	0-5 volts, 0-50 volts, 0-30 amperes.....	16.00
*252	0-5 volts, 0-100 volts, 0-30 amperes.....	16.00
253	0-6.5 volts, 0-130 volts, 0-30 amperes.....	16.00

All volt-ammeters will be furnished with either 0-1, 0-4, 0-10 or 0-15 amperes, instead of 0-30 amperes, if specified on order.

*Specially adjusted for resistance measurements.

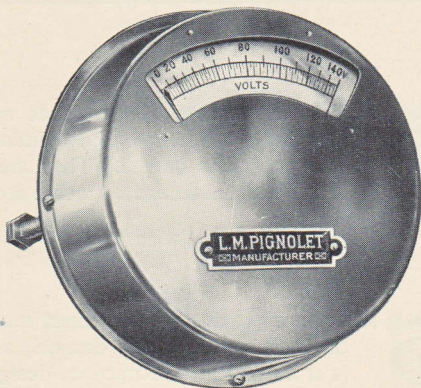
Leather Cases.\$1.00

Dead Beat Attachments..... .50

Other ranges or Combinations of Readings will be Furnished to Order.

PIGNOLET

SWITCH BOARD INSTRUMENTS



VOLTMETERS

Catalogue Number	Range	List Price Each
700	0-10, Fifth volt divisions.....	\$10.00
701	0-25, Half volt divisions.....	10.00
702	0-50, Single volt divisions.....	10.00
703	0-100, Half volt divisions.....	10.00
704	0-150, Two volt divisions.....	10.50

AMMETERS

750	0-5, Tenth ampere divisions.....	10.00
751	0-10, Fifth ampere divisions.....	10.00
752	0-25, Half ampere divisions.....	10.00
753	0-50, Single ampere divisions.....	10.00
754	0-100, Two ampere divisions.....	11.00

Nos. 750, 751, 752 and 753 can be furnished with zero in center, which obviates the necessity of reversing switch for charging and discharging storage batteries.

OTHER READINGS ARE SPECIAL AND WILL BE FURNISHED TO ORDER

PIGNOLET

SWITCH BOARD INSTRUMENTS

THESE instruments are compact and especially adapted to installations where space is limited. They are 5 inches in diameter and 1½ inches deep.

THE case is provided with a sheet metal cover finished in Black Enamel, and is of a simple, yet attractive, design. Other finishes will be furnished to order.

THESE instruments are fastened to the switchboard by two bolts, which are provided on the back of each meter, and which also serve to convey the current, so that but two holes are required in the board.

HOW TO MEASURE THE AMPERES OF PRIMARY BATTERIES.

Use short and thick wires or cables to connect the battery and instrument, if the battery is capable of furnishing a fairly strong current (for example an ordinary dry battery), otherwise the amperes of the battery will be cut down. Disconnect the battery as soon as a reading can be taken, as during this test the battery is short-circuited and would soon become exhausted.

HOW TO TEST STORAGE BATTERIES.

Test by volts only which are between 2.5 and 2.6 volts for each cell when the battery is full and the charging current is on, 2.25 volts when full and the current is off, and 1.8 volts when exhausted. Some makes vary a little from the above, but the figures given are accurate or sufficiently so for all batteries.

Test the batteries when drawing from them a current suited to their capacity, as idle batteries may show a high voltage even when nearly exhausted.

Never use an ammeter for testing storage batteries, except to measure the current of charge or discharge. The capacity of storage batteries is rated in ampere-hours obtained by multiplying the normal discharge in amperes by the time the battery will furnish such current. For example, a 60 ampere-hour battery will furnish $7\frac{1}{2}$ amperes for 8 hours. An 80 ampere-hour battery, 10 amperes for 8 hours.

During discharge, the volts fall rapidly from 2.25 to about 2, where they remain nearly all the time falling to 1.8 when the battery is exhausted or in a few batteries to 1.7.

HOW TO TEST FOR GROUNDS IN DYNAMOS, MOTORS, COILS, MAGNETS, ETC.

If there is current on the device, connect one binding post of the voltmeter to one side of the circuit and connect the other post to the shaft, core or metal frame of the device being tested. If no deflection, connect the voltmeter to the other side of the circuit and repeat the test, as the absence of a deflection may be due to a ground at the point where the device joins the side of the circuit to which the voltmeter is connected. But if a battery or independent current is used, one test is sufficient.

HOW TO TEST ARMATURES FOR OPEN OR SHORT CIRCUITS.

Connect a cell of dry battery to an ammeter of any range between 10 and 30 amperes, Provide the circuit with two terminals which when touched together cause a considerable deflection of the meter. If one cell is not sufficient, use two or three in multiple. Also, the connecting wires or cables should not be long and should be large enough to avoid cutting down the current too much.

Touch the terminals to adjoining segments of the commutator (one terminal to each segment) or to the ends of adjoining windings all around the armature. The amperes will be practically equal, except in the case of a short-circuit in a coil or between two segments, where they will be greater. In the case of an open circuit, there will be no current or a very small one.

HOW TO TEST SHORT-CIRCUITS IN COILS, MAGNETS, ETC.

If the resistance of the coil or magnet be known, check the resistance off with the voltmeter in the way directed for determining resistances. If this resistance is not known, but the device has two or more parts of the same size and number of turns of wire, test each part separately with the voltmeter and battery. If no short-circuit, the deflection will be the same through all the parts, but if a short-circuit exists, the deflection of the voltmeter will be higher through this part. If the resistance of the device is too low to affect the reading of the voltmeter, pass a steady current through the device and connect the voltmeter in multiple across the terminals of the device. In the part where the short-circuit exists the voltage will be low.

HOW TO MEASURE THE RESISTANCES OF COILS, LINES, CIRCUITS, ETC.

Resistance is easily determined with the specially adjusted instruments by Ohm's Law that resistance equals volts divided by amperes. First, measure the volts of the battery or current used. Second, obtain the amperes when the coil or line, etc., is connected in series with the voltmeter and battery, as shown in the figure. The amperes are read on the voltmeter scale, each division of which equals one thousandth of an ampere, (one mil-ampere) in these instruments. Third, divide the volts by the amperes and subtract the resistance of the voltmeter.

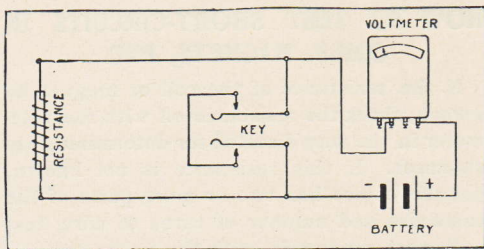


FIGURE 1

For example, suppose the battery to have 4.5 volts and the current to be .020 amperes (20 mil-amperes) indicated by a deflection of 20 scale divisions of the voltmeter scale when the coil whose resistance is to be determined, is connected in circuit. Then, 4.5 divided by .020 equals 225 Ohms. This includes the resistance of the voltmeter, which in this case has a range of 5 volts and a resistance of 100 Ohms. Subtract 100 and the remainder, 125 Ohms, is the resistance of the coil.

To save labor, a table is furnished showing the resistance for each division of the voltmeter scale when 2, 3 or 4 new dry cells of $1\frac{1}{2}$ volts each are used with the 5 volt coil.

The range of measurements with the 5 volt coil, can be increased by using a battery of higher voltage than 5, but it is not advisable to go above 10 volts for fear of damaging the instrument in case of short-circuit. The dry batteries should be fresh and of full strength. Test them before use by making connection at the point where the key is located in the diagram. A storage battery or any battery can be used that has a low internal resistance and a constant voltage.

Resistances below 2 Ohms can be measured by passing a known current through them and measuring the volts at their terminals. Dividing the volts by the amperes gives the Ohms resistance.

Resistances can be determined with any of our voltmeters, whether specially adjusted or not, by multiplying the volts of the current used by the resistance of the instrument, dividing the result by the volts with the line, coil or other device in circuit as shown in the figure one, and subtracting the resistance of the voltmeter.

For example: suppose volt-ammeter No. 253 to be used, the volts of the battery to be 6 and the volts with the device in circuit, to be 4.5. Then 6 multiplied by 150 (the resistance of the voltmeter) equals 900. Dividing 900 by 4. gives 200. Subtracting 150 gives 50 Ohms as answer.

How to measure the resistance of a grounded line. Connect the voltmeter and the battery to a good ground in the office and to the line.

How to test grounded lines or metallic lines instantly. Connect the voltmeter and battery to a plug ready to be inserted in the jack of any line, as shown in the figure.

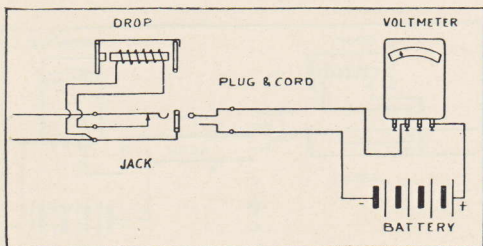


FIGURE 2

Bad joints and loose connections are readily detected by the refusal of the pointer to settle down and become perfectly quiet. The best time to test outside lines is on a windy and wet day, when loose connections, swinging crosses and grounds are sure to show up. A loose connection results usually in a violent and continued agitation of the pointer. On a swinging cross or swinging ground, the pointer tends to settle at one point but lunges forward violently at intervals when the swinging cross or ground occurs. It is of course impossible to arrive accurately at the resistance of a line until such a fault is removed.

Every telephone exchange or other system should have a record of the resistance of all the lines taken periodically. If we know what the lines measure when working right, the different results when they "go wrong" will probably reveal the nature of the trouble at once. Thus, on a grounded country line, if the instrument reads higher than usual, we know that the line has a partial ground. If the deflection is less than usual, we know a part of the line is disconnected, presumably by a break.

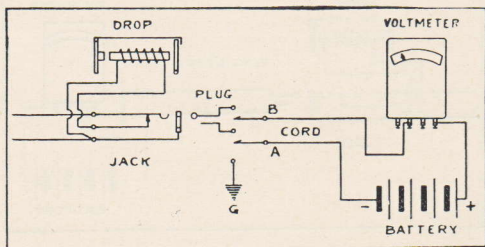


FIGURE 3

By the connections shown in the figure, the two sides of a metallic line can be tested separately for freedom from grounds, any ground on either side showing up in a corresponding deflection. Switch A can be set to line or to ground G. With A grounded, use switch B to test both sides of line for grounds.

Grounded telephone lines can be tested for freedom from grounds only when all bells have been removed from the line, except those having ring through condensers in series to prevent the escape of the testing current to earth. On country lines equipped with telephones having condensers in the talking circuit only, a test for freedom from grounds can be made if all receivers are removed from the switch hooks while such test is being made. This, according to the usual practice, cuts out the bells and leaves only the talking circuit with condenser in series bridged from line to ground at each telephone.

Condensers in the talking circuits of bridging telephones can be tested, by ringing the party and immediately plugging the voltmeter on to the line. The pointer will assume a certain deflection before the party answers. If the condenser is good, the pointer should fall back nearer zero. If the pointer flies ahead, the answering telephone has no condenser or if it has a condenser, it has gone bad.

It is impossible to exactly locate trouble on grounded country lines. On a grounded toll line, a ground can be located by measuring from both ends as indicated in the figure. We can not assume that the fault F is a perfect ground as it may have a high resistance, and a high resistance ground close to A will measure the same from that point as a more perfect ground further away. Hence, we must find out how bad the fault is, as we can not tell where it is until we know how bad it is.

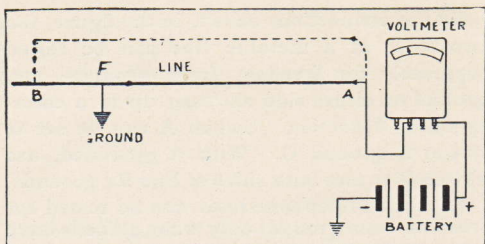


FIGURE 4

First connect to a perfect ground at the office and test out from A, setting down the Ohms as the resistance of the wire from A to F plus the resistance of the fault. Then test back from B towards the fault (usually making the test from A by means of some other wire of known resistance) and set down the resistance shown as the resistance of the wire from B to F plus the resistance of the fault. For example:

Line wire A to F plus fault equals 268 Ohms.
 " " B to F " " " 410 "

Adding the two together, we have the line from A to F plus the line from B to F plus twice the fault equals 678 Ohms. As the line is No. 10 iron wire twenty miles long, its resistance according to the wire tables is 20 Ohms a mile; hence its total resistance is 480 Ohms. Subtracting this from 678 Ohms, the resulting difference, 198 Ohms, represents twice the resistance of the fault. Half of this is 99 Ohms, the true resistance of the fault. Subtracting 99 from the first reading of 263 Ohms gives 169 Ohms of wire between A and the fault. As the wire is 20 Ohms to the mile, the distance from A to the fault is 169 divided by 20 or 8 45 miles. Faults in cables, telegraph or other lines or circuits are located in the same way as described above.

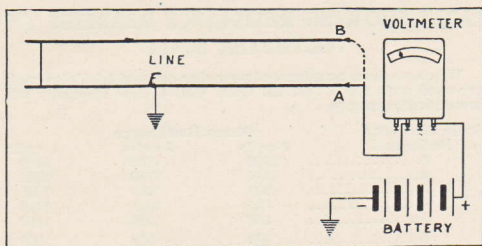


FIGURE 5

In locating a ground on one side of a metallic line, the line wires must be connected together (tied) at the distant end as indicated in the figure. This gives the same condition as the single grounded line, except that the line now begins and ends at the same point, which makes accurate and rapid fault finding an easy matter.

How to test inside electric light, telephone, annunciator or other circuits. Test for grounds as indicated for telephone circuits. To test for short-circuits, all lamps and other devices must be disconnected and the two ends of the circuit connected to the voltmeter and battery, as shown in the figure which accompanies the directions for measuring resistance.

The directions given are for the more prominent and useful tests, but many others which can be performed with this instrument will suggest themselves to the user.

The instruments should be handled with care, as violent use may affect their accuracy. Given due care, this inexpensive little instrument will soon become indispensable and increase in usefulness and value.

TABLE SHOWING RESISTANCE READINGS OF VOLTMETER SCALE

When various numbers of new dry cells of 1.5 Volts each are used with the 5 Volt 100 Ohm Coil of the specially adjusted instruments.

Scale Divisions of Deflection	Ohms Resistance		
	2 cells	3 cells	4 cells
1.....	2900	4400	5900
2.....	1400	2150	2900
3.....	900	1400	1900
4.....	650	1025	1400
5.....	500	800	1100
6.....	400	650	900
7.....	329	543	757
8.....	275	463	650
9.....	233	400	567
10.....	200	350	500
11.....	173	309	445
12.....	150	275	400
13.....	131	246	362
14.....	114	221	329
15.....	100	200	300
16.....	88	181	275
17.....	76	165	253
18.....	67	150	233
19.....	58	137	216
20.....	50	125	200
21.....	43	114	186
22.....	36	105	173
23.....	30	96	161
24.....	25	88	150
25.....	20	80	140
26.....	15	73	131
27.....	11	67	122
28.....	7	61	114
29.....	5	55	107
30.....	0	50	100
31.....	.....	45	93
32.....	.....	41	87
33.....	.....	36	82
34.....	.....	32	76
35.....	.....	29	71
36.....	.....	25	67
37.....	.....	22	62
38.....	.....	18	58
39.....	.....	15	54
40.....	.....	13	50
41.....	.....	10	46
42.....	.....	7	43
43.....	.....	5	40
44.....	.....	2	36
45.....	.....	0	33
46.....	.....	.....	30
47.....	.....	.....	28
48.....	.....	.....	25
49.....	.....	.....	22
50.....	.....	.....	20

Special Readings and Combinations

A few instruments with special readings and combinations are listed below, but others can be furnished. If the readings listed do not suit, let us know your requirements. We can probably fill them. In any event, we will let you know at once exactly what we can do.

Two-Reading Ammeters

0 to $\frac{1}{2}$ ampere and 0 to 30 amperes \$11.00

0 to 1 ampere and 0 to 30 amperes \$11.00

0 to 4 amperes and 0 to 30 amperes \$11.00

0 to 10 amperes and 0 to 30 amperes \$11.00

Any ampere reading listed can be furnished instead of 0 to 30 in the above, if specified when ordering.

Volt-Ammeters With Two Readings In Amperes and One Reading In Volts

0 to 5, 10 or 20 volts, 0 to 1 or 2 amperes and 0 to 10 or 20 amperes \$18.00

0 to 130 volts, 0 to 1 or 2 amperes and 0 to 10 or 20 amperes \$19.00

Volt-Ammeters With Two Readings In Volts and Two Readings In Amperes

0 to 5 volts, 0 to 25 volts, 0 to 1 or 2 amperes and 0 to 10 or 20 amperes \$20.00

0 to 5 volts, 0 to 100 volts, 0 to 1 or 2 amperes and 0 to 10 or 20 amperes \$20.00

0 to 6.5 volts, 0 to 130 volts, 0 to 1 or 2 amperes and 0 to 10 or 20 amperes \$21.00

Four Reading Volt-Ammeters

0 to 5 volts, 0 to 25 volts, 0 to 100 volts, and 0 to 30 amperes \$19.00

0 to 5 volts, 0 to 25 volts, 0 to 200 volts, and 0 to 30 amperes \$20.00

0 to 6.5 volts, 0 to 130 volts, 0 to 260 volts and 0 to 30 amperes \$21.00

